METHOD OF TEST
DETERMINING THE STANDARD MOISTURE-DENSITY RELATIONSHIP OF AGGREGATE-CEMENT MIXTURES
FIELD PROCEDURES FOR AASHTO TEST METHOD T-134

SCOPE

This test is used to determine the maximum density and corresponding optimum moisture content of aggregate-cement mixtures when compacted before cement hydration occurs.

PROCEDURE

A. Apparatus

1. Mold. A cylindrical metal mold having a capacity of 944 cm^3 (1/30 cu. ft.), with internal diameter of 101.6 ± 0.4 mm (4.000 ± 0.016 in.) and height of 116.43 ± 0.13 mm (4.584 ± 0.005 in.), and with a detachable metal collar approximately 60 mm (2⅜ in.) in height. The mold shall be so constructed that it can be fastened firmly to a detachable circular metal base.

2. Compaction Device. A 2.495 ± 0.009 kg (5.50 ± 0.02 lb.) rammer having a 50.8 ± 0.127 mm (2.000 ± 0.005 in.) diameter circular face, falling inside a cage of four metal rods. The ability of delivering a 304.8 ± 1.524 mm (12.00 ± .06 in.) free fall of the rammer to each of three layers is made available by means of a three position rammer stop. The device shall be bolted to a 91 kg (200 lb.) concrete pedestal or a base of equivalent rigidity.

3. Extruder. A jack or lever adapted for the purpose of extruding the compacted sample from the mold.

4. Balance. A balance or scale of at least 5000 gram capacity, capable of weighing to 0.5 gram.

5. Drying Equipment. A hot plate or an oven capable of maintaining a temperature of at least 110 ± 5°C (230 ± 9°F).

6. Straightedge. A rigid steel straightedge, 225 mm (9 in.) long, having one straight, sharpened beveled edge.

7. Moisture Pans. Tared, numbered moisture pans approximately 300 mm (12 in.) in diameter and 50 mm (2 in.) deep.

8. Mixing Equipment. Miscellaneous tools, such as mixing pans, spoon, putty knife, graduate, tared weighing scoop, and rubber mallet.

B. Calibration

1. Check the height of hammer fall periodically. With the hammer held tight to the stop in the bottom indent, set the distance from the bottom face of the hammer to the top of the detachable base to 343.7 mm (13.53 in.). The cage shall be vertical and so centered with the mold that the falling hammer will just clear the mold edge. The nuts holding the cage to the frame shall be well tightened, and keep the cage and hammer clean to insure a free fall.

2. Calibrate the volume of the mold yearly by the water content method to insure it's within tolerance. Field checks may be periodically made by measurements with steel rule and appropriate calculations.

C. Sample Preparation

1. Quarter the field sample being tested into two representative samples of approximately 5000 grams each, then dry each to a constant weight.

2. Sieve the samples separately over the 19.0 mm (¾ in.) and the 4.75 mm (#4) sieve. Determine the oven-dry mass, retained on the 19.0 mm (¾ in.) and the 4.75 mm (#4) sieve and passing the 4.75 mm (#4) sieve for the first sample. Discard the material retained on the 19.0 mm (¾ in.) sieve from both the first and second sample and discard the material from the second sample passing the 4.75 mm (#4) sieve. The remaining material retained on the 4.75 mm (#4) sieve shall be combined to equal the amount retained on the 19.0 mm (¾ in.) and 4.75 mm (#4) sieve of the first sample.

3. Prepare the material retained on the 4.75 mm (#4) sieve to a saturated, surface-dry condition.

D. Test Procedure

1. Sprinkle and thoroughly mix the cement into material passing the 4.75 mm (#4) sieve in the amount needed, based on the total mass of the dry mixture (i.e., 4700 grams of oven dry aggregate and 9 percent cement mixture (0.09 x 4700 g) ÷ (1.00 - 0.09) = 465 grams of cement).

   Uniformly sprinkle water and mix into the mixture until a handful of material squeezed tightly into the palm of the hand retains its cast and will fracture with only slight pressure. Add the saturated surface-dry aggregate and mix thoroughly.

2. Weigh and place in the assembled mold an amount of the dampened sample that, after compaction, will yield about 3 mm (0.1 in.) more than α the height of the mold, and compact with 25 uniformly distributed blows of the free falling hammer while the hammer stop is in the lower indent. During this compaction, rotate the mold about 1/6 turn between each blow, and operate the hammer with a flipping motion that will allow the hammer to contact the stop, then fall completely free of chain drag to deliver the full blow to the aggregate-cement sample. Adjust the weight of aggregate-cement taken for the second and third layers to give compacted layers roughly 3 mm (0.1 in.) to 5 mm (0.2 in.) above the heights needed, and compact each by 25 blows as above with the hammer stop at the middle and top indent respectively. During this entire procedure, do not allow the cage rods, hammer and hammer face to collect material.

3. Place the mold on a table and remove the collar. Using the straightedge cut off the excess soil in thin layers until level with the mold top. Fill any voids, resulting from small aggregate being removed, with fines and hand compact. Do not remove any large aggregate projecting above the top of the mold, but finish the aggregate-cement to arrive at a surface that will average level full. If the material projects more than 10 mm (⅜ in.) above the mold, or if the mold is not completely full, the compactive effort is incorrect. Extrude the sample, pulverize, return to the mixing pan and compact a new sample.

4. Detach the mold and contained sample from the base plate and weigh by means appropriate to give the net mass of compacted sample. Extrude the sample and take a 700 gram moisture sample from a vertical pie shape section. Pulverize the remaining portion and return to the mixing pan.

5. Add water, not to exceed 2% of the remaining sample mass with constant stirring until the aggregate-cement mixture is uniformly mixed. Compact a second sample as above. Repeat this procedure of adding water, compacting, and taking a moisture sample with increasing water content until a compacted mass is reached that is less than the one preceding.

   Complete the procedure of Section D within one hour.

E. Calculations

Mass of moisture Loss = (Wet Material + Pan) - (Dry Material + Pan)

$$\%\text{ Moisture} = \frac{(\text{Mass of Moisture Loss})(100)}{(\text{Dry Material} + \text{Pan}) - (\text{Pan})}$$

Example: Wet material + pan = 500 g
Dry material + pan = 446 g
Pan = 147 g

$$\frac{(500 - 446)(100)}{(446 - 147)} = 18.1\%$$

$$\text{Compacted Dry Density} = \frac{(\text{Wet Mass Compacted Material})(100)}{(\%\ \text{Moisture} + 100)(944 \text{ x } 10^{-6}\text{m}^3)\,1000\text{ g/kg}}$$

Example: Wet mass compacted material = 1873 g
Volume of mold = 944 cm^3

$$\frac{(1873)(100)}{(18.1 + 100)(944 \text{ x } 10^{-6})(1000)} = 1680\text{ kg/m}^3$$

F. Moisture-Density Relationship

1. The calculations in Section E shall be made for each of the compacted specimens. Plot the dry unit weights as ordinates (vertical) and the corresponding moisture contents as abscissas (horizontal).

2. Using the resulting plotted points, draw a smooth curve. The peak of the curve designates the optimum moisture content and the corresponding dry density the maximum, or Proctor density.